

Indexing Metadata/Description

- › **Device/equipment:** Transcutaneous Electrical Nerve Stimulation (TENS): Adults
- › **Synonyms:** N/A
- › **Area(s) of specialty:** Acute care, cardiovascular rehabilitation, pulmonary rehabilitation, hand therapy, oncology, neurological rehabilitation, orthopedic rehabilitation, sports rehabilitation, women's health, wound management
- › **Description/use**
 - Transcutaneous electrical nerve stimulation (TENS)⁽¹⁾
 - Electrical stimulation is delivered through electrodes placed on the skin
 - Units can be powered by batteries to allow for ease of use during functional tasks
 - Most often used in an effort to reduce/eliminate pain
 - “Standard” TENS devices⁽¹⁾
 - Administer biphasic pulsed currents
 - Pulse durations range from 50 to 1,000 μ s
 - Pulse frequencies range from 1 to 250 pps
 - Pulse patterns are typically continuous or burst
 - Common terminology
 - Pulse amplitude – milliamps (mA)⁽³⁾
 - Pulse duration – microseconds (μ s)⁽⁴⁾
 - Pulse frequency
 - Pulses per second (pps)⁽¹⁾
 - Hertz (Hz)⁽¹⁾
 - Note: Hz and pps are equivalent units of measure (1 Hz = 1 pps)
 - Waveform – “A visual representation of the flow of electric current through a conductor on an amplitude-time plot”⁽¹⁾
 - Biphasic pulsatile current⁽¹⁾
 - A type of waveform
 - There is a positive and a negative phase
 - Low-frequency TENS is generally considered < 10 Hz⁽⁴⁾
 - High-frequency TENS is generally considered > 50 Hz⁽⁴⁾
- › **Principles**
 - Pain is thought to be controlled by TENS in one of two ways, depending on the parameters used⁽⁶⁾
 - Sensory level stimulation
 - Gate control theory – “Gait control uses sensory information on A- β -afferent nerves to interfere with the transmission of pain on A- δ and C afferent fibers”⁽⁶⁾
 - Motor level stimulation
 - The goal of this type of stimulation is to cause the “release of endogenous opiate-like substances”⁽⁶⁾

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- In theory, the parameters of the TENS unit are selected in an effort to stimulate certain nerve fibers, thereby generating distinctive results (e.g., utilizing parameters for acupuncture-like TENS, including low frequency and high intensity, yielding muscle twitches and pain relief)⁽⁵⁾
 - The selected parameters and setup, when administering TENS (e.g., intensity, frequency, and location of stimulation), are likely to directly affect an individual's pain level⁽⁷⁾
 - Based on a randomized controlled trial
 - One hundred and eighty healthy individuals were randomized to 1 of 6 groups
 - Three of the groups underwent low-frequency TENS set at 4 Hz; the intensity was “strong but comfortable”; pulse duration was 200 µs for 30 minutes
 - Segmental stimulation – TENS administered on the forearm
 - Extrasegmental stimulation – TENS administered just distal to the fibula head
 - Three of the groups underwent high-frequency TENS set at 110 Hz; the stimulation site was segmental, extrasegmental, or combination; the intensity was “highest tolerable”; pulse duration was 200 µs for 30 minutes
 - The control and sham group data were obtained from a previous study (60 individuals)
 - Outcome measure – pressure pain thresholds via a pressure algometer (measurements were taken at the first dorsal interossei muscle)
 - Results
 - Two of the three groups (segmental and combination) receiving high-frequency TENS demonstrated a significant increase in pressure pain thresholds (or “hypoalgesic effect”)
 - The other groups studied experienced outcomes comparable to the sham data
 - When using TENS, the pulse frequency might not be a factor in reducing the patient's pain level, as long as the intensity is perceived as “strong but comfortable”; however; further research is warranted⁽³⁾
 - Based on a systematic review
 - The review was comprised of studies on healthy subjects
 - The review included 13 experimental studies
 - The authors reported numerous methodological concerns (e.g., small sample sizes, challenges in blinding)
 - Mechanical pain thresholds were reported to be increased following the application of TENS at a “strong but comfortable intensity” in healthy individuals⁽⁸⁾
 - Based on a randomized controlled trial involving 66 healthy individuals (13 males; 53 females)
 - TENS intervention
 - Electrodes were applied to the hands and forearms
 - Frequency was 100 Hz; pulse duration was 150 µs
 - Two levels of intensity were applied; one type on each hand
 - Level 1 – intensity was delivered at the individual's sensory threshold
 - Level 2 – intensity was delivered at the individual's “strong but comfortable” level; intensity was increased throughout intervention on regular intervals until this level was obtained
 - Randomization took place to determine which hand received which type of treatment
 - Outcome measure – analogue pressure algometer
 - Results
 - The mechanical pain threshold significantly increased with the level 2 stimulation method (in the ipsilateral extremity)
 - There was no significant increase in pain threshold with the level 1 intensity
- › **HCPCS codes:** E0720, E0730
- › **G-Codes**
- **Mobility G-code set**
 - G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
 - G8979, Mobility: walking & moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
 - G8980, Mobility: walking & moving around functional limitation, discharge status, at discharge from therapy or to end reporting

• **Changing & Maintaining Body Position G-code set**

- G8981, Changing & maintaining body position functional limitation, current status, at therapy episode outset and at reporting intervals
- G8982, Changing & maintaining body position functional limitation, projected goal status, at therapy episode outset , at reporting intervals, and at discharge or to end reporting
- G8983, Changing & maintaining body position functional limitation, discharge status, at discharge from therapy or to end reporting

• **Carrying, Moving & Handling Objects G-code set**

- G8984, Carrying, moving & handling objects functional limitation, current status, at therapy episode outset and at reporting intervals
- G8985, Carrying, moving & handling objects functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8986, Carrying, moving & handling objects functional limitation, discharge status, at discharge from therapy or to end reporting

• **Self Care G-code set**

- G8987, Self care functional limitation, current status, at therapy episode outset and at reporting intervals
- G8988, Self care functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8989, Self care functional limitation, discharge status, at discharge from therapy or to end reporting

• **Other PT/OT Primary G-code set**

- G8990, Other physical or occupational primary functional limitation, current status, at therapy episode outset and at reporting intervals
- G8991, Other physical or occupational primary functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8992, Other physical or occupational primary functional limitation, discharge status, at discharge from therapy or to end reporting

• **Other PT/OT Subsequent G-code set**

- G8993, Other physical or occupational subsequent functional limitation, current status, at therapy episode outset and at reporting intervals
- G8994, Other physical or occupational subsequent functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8995, Other physical or occupational subsequent functional limitation, discharge status, at discharge from therapy or to end reporting

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G-code Modifier	Impairment Limitation Restriction
CH	0 percent impaired, limited or restricted
CI	At least 1 percent but less than 20 percent impaired, limited or restricted
CJ	At least 20 percent but less than 40 percent impaired, limited or restricted
CK	At least 40 percent but less than 60 percent impaired, limited or restricted
CL	At least 60 percent but less than 80 percent impaired, limited or restricted
CM	At least 80 percent but less than 100 percent impaired, limited or restricted
CN	100 percent impaired, limited or restricted

Source: <http://www.cms.gov>

› **Reimbursement:** Clinicians are advised to check with insurance providers prior to the administration of TENS. In the United States, only TENS units approved by the US Food and Drug Administration (FDA) are covered. Medical insurance providers might require that the patient rent the TENS unit (versus purchasing the unit) and might limit the length of time a patient can keep the rental unit. Reimbursement depends on chronicity, etiology, and severity of pain. A physician's prescription is usually required for reimbursement

Indications for device/equipment

- › TENS is generally used to treat pain in the acute or chronic stages^(9,10)
- › TENS might be used in individuals with various painful conditions, including but not limited to⁽¹⁾
 - rheumatoid arthritis
 - osteoarthritis
 - postsurgical pain
 - primary dysmenorrhea
 - delayed-onset muscle soreness⁽³¹⁾
 - postmastectomy pain⁽³⁴⁾
 - central and peripheral neuropathic pain⁽³⁵⁾
- › TENS has been used for many other conditions; see *Treatment summary*, below, for examples
- › Advantages of TENS for pain relief
 - Noninvasive⁽¹¹⁾
 - Considered safe⁽¹¹⁾
 - Ease of use/portability of units⁽¹⁾

Guidelines for use of device/equipment

- › TENS can be applied in the following ways
 - Sensory level stimulation
 - Referred to as “conventional” TENS or “high rate” TENS⁽⁹⁾
 - High pulse frequency; short pulse duration⁽¹⁾
 - Goal is to stimulate cutaneous afferents Aβ (large diameter)⁽⁵⁾
 - Pain is generally ameliorated while the TENS device is in use; pain tends to return upon ending treatment with the unit⁽¹⁾
 - Might be used for acute or chronic pain⁽⁹⁾
 - Motor level stimulation
 - Referred to as “acupuncture-like” TENS or “strong low rate” TENS⁽⁹⁾
 - Low pulse frequency; long pulse duration⁽¹⁾
 - Goal is to cause muscular twitches, thereby leading to the stimulation of muscle afferents (small diameter)⁽⁵⁾
 - Pain is generally ameliorated for many hours after the device is shut off⁽¹⁾
 - Might be used for the treatment of chronic pain⁽⁹⁾
 - Parameters of motor and sensory level stimulation are sometimes blended^(1,9)
 - “Brief intense” TENS⁽¹⁾
 - High pulse frequency; long pulse duration
 - Goal is to stimulate small diameter cutaneous afferents⁽⁵⁾
 - Generally implemented while a painful technique is carried out (e.g., debridement)
 - “Burst mode” TENS⁽⁹⁾
 - Pain is generally ameliorated for many hours after intervention
 - This method uses “pulse trains” or “bursts” of pulses
 - Noxious level stimulation⁽¹⁾
 - Referred to as “hyperstimulation”
 - Stimulation is administered through probe-like electrodes

- Might be used when other TENS methods have failed (generally viewed as a last resort)
- As the name implies, this type of stimulation is painful; informed consent must be obtained
- The desired outcome is pain relief following the stimulation
- Authors of a study in Turkey investigating the optimal frequency for TENS application suggest that higher frequencies of conventional TENS result in higher pain threshold and pain tolerance values⁽³⁶⁾
 - Frequencies of 60 pps and 150 pps were compared
 - Pain threshold and tolerance values were greater when a frequency of 150 pps was used, and they remained higher 30 minutes after cessation of TENS
- › TENS can be used independently at home by the patient once properly trained⁽⁵⁾
- › Variation in methods of application are evolving
 - Form fitting conductive garments have been developed for administration of TENS in cases where
 - the area receiving stimulation is inaccessible to the recipient or caregivers with the use of conventional electrodes, tapes, and lead wires
 - the area receiving stimulation is so large or the areas so numerous, that conventional electrodes, tapes, and lead wires are not practical
 - the recipient has a skin condition or other medical condition that prevents the application of conventional electrodes, tapes, and lead wires
 - Examples of conductive garments include conductive gloves, socks, knee sleeves, and vests
 - Simultaneous application of ice and TENS is one technique gaining popularity in clinical practice for pain relief⁽³⁷⁾
 - Authors of a randomized controlled trial conducted in Brazil suggest that the use of these modalities combined has a potentiating effect
 - One hundred and twelve healthy volunteers were randomly allocated to one of 7 groups: control, placebo TENS, conventional TENS, burst TENS, cryotherapy, cryotherapy in combination with conventional TENS, cryotherapy in combination with burst TENS
 - Outcome measure was pressure pain threshold
 - Cryotherapy in combination with burst TENS provided greater analgesia compared with other groups

Contraindications/Precautions to device/equipment

- › Clinicians should follow the guidelines of their clinic/hospital and what is ordered by the patient's physician. The summary below is meant to serve as a guide, not to replace orders from a physician or a clinic's specific protocols
- › Contraindications to TENS⁽⁹⁾
 - Demand-type pacemaker
 - Over the chest of patient with cardiac disease
 - Over the eyes
 - Over laryngeal or pharyngeal muscles
 - Head/neck of a patient with a history of a stroke
 - Head/neck of a patient with a history of epilepsy
 - Over mucosal membranes
- › Contraindications to electrotherapy in general should be observed. **Electrotherapy** contraindications/precautions (in some cases, **when approved by the treating physician**, electrotherapy might be used under some of the circumstances listed below when benefits outweigh the perceived risk).⁽¹⁾ (Note: As always, the clinician is advised to use his or her professional judgment when deciding to implement a modality as part of a treatment regimen and refer to the treating physician as indicated)
 - Do not place electrodes near:
 - carotid bodies, cardiac pacemakers or implantable cardioverter defibrillators, phrenic nerve or urinary bladder stimulators, eyes, gonads
 - Osteomyelitis
 - Hemorrhage
 - Impaired sensation, mental status, communication
 - Cardiovascular disease
 - Malignancy
 - Dermatological conditions

- Proximity of electromagnetic radiation
 - In pregnant women, near the pelvis, lumbar spine, hips, abdomen
 - In patients with stroke or seizures, near the neck
 - History of spontaneous abortion in pregnant women
- › Precautions for TENS
- Skin irritation and redness
 - Hives, welts, and allergic skin reactions can occur rarely
 - TENS should not be placed on broken skin areas or wounds but can be placed around the wounds
 - Skin infection
 - Research indicates that there is no risk of infection from reusing electrode pads on the same patient as long as the clinician follows the manufacturer’s guidelines⁽²⁾
 - Electrode pads should not be shared by different patients

Examination

› **Contraindications/precautions to examination**

- History taking and examination procedures depend largely on the underlying condition and reason for referral. The information listed below is meant to serve as a guide/overview. Clinicians should supplement or modify the recommendations listed below as indicated and appropriate given the unique circumstances of the patient

› **History**

• **History of present illness/injury for which the device is needed**

- **Mechanism of injury or etiology of illness:** What is the current reason for referral?
- **Course of treatment**
 - **Medical management:** Medical management will vary depending on the specific underlying condition; document any reported diagnostic tests, surgeries and other therapeutic interventions, and/or hospital stays
 - **Medications for current illness/injury:** Determine what medications the clinician has prescribed; are they being taken? Are they effective? Is the patient comfortable with the medications he or she is taking? Is the patient looking for an alternative approach to pain relief?
 - **Diagnostic tests completed:** Diagnostic tests will depend largely on clinical history, presenting signs and symptoms, and suspected underlying condition
 - **Home remedies/alternative therapies:** Document any use of home remedies (e.g., ice or heating pack) or alternative therapies (e.g., acupuncture) and whether or not they help
 - **Previous therapy:** Document whether patient has had occupational or physical therapy for this or other conditions and what specific treatments (e.g., TENS) were helpful or not helpful
- **Aggravating/easing factors** (and length of time each item is performed before the symptoms come on or are eased): Document any reported aggravating or easing factors
- **Body chart:** Use body chart to document location and nature of symptoms
- **Nature of symptoms:** Document nature of symptoms (constant vs. intermittent, sharp, dull, aching, burning, numbness, tingling); ask patient to describe his or her perceived functional limitations
- **Rating of symptoms:** Use a visual analog scale (VAS) or the Numeric Rating Scale (NRS), a 0-10scale, to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much)
- **Pattern of symptoms:** Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables
- **Sleep disturbance:** Document number of wakings/night related to condition as applicable. If patient complains of nighttime pain inquire whether the pain wakes the patient when he or she moves or while lying still. Is nighttime waking dependent on position? Does patient report daytime fatigue related to sleep disturbance?
- **Other symptoms:** Document other symptoms the patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to a physician (e.g., dizziness, bowel/bladder/sexual dysfunction, saddle anesthesia)
- **Respiratory status:** Is there any respiratory compromise? Any past or present use of supplemental oxygen or mechanical ventilation? Does the patient smoke? Obtain results of recent pulmonary function tests where relevant
- **Barriers to learning**
 - **Are there any barriers to learning? Yes__ No__**
 - **If Yes, describe _____**

- **Medical history**

- **Past medical history**

- **Previous history of same/similar diagnosis**

- **Comorbid diagnoses:** Ask the patient about other problems, including diabetes, cancer, heart disease, pregnancy complications, psychiatric disorders, orthopedic disorders, etc. Be sure to ask the patient directly regarding contraindications/precautions to use of TENS

- **Medications previously prescribed:** Obtain a comprehensive list of medications prescribed and/or being taken (including over-the-counter drugs)

- **Other symptoms:** Ask the patient about other symptoms he/she might be experiencing

- **Social/occupational history**

- **Patient's goals:** Document what the patient hopes to accomplish with therapy and in general

- **Vocation/avocation and associated repetitive behaviors, if any:** Does the patient participate in recreational or competitive sports? Does the patient work or attend school?

- **Functional limitations/assistance with ADLs/adaptive equipment:** Inquire about limitations with self-care, home management, work, community, and leisure

- **Living environment:** Stairs, number of floors in home, with whom the patient lives, caregivers, etc. Identify if there are barriers to independence in the home; any modifications necessary?

› **Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting.)** Evaluation procedures should be modified according to the patient's age, diagnosis, and any unique circumstances; the information listed below is meant to serve as a guide only. Complete a general evaluation as indicated and appropriate

- **Arousal, attention, cognition (including memory, problem solving)**

- Complete a cognitive assessment as indicated and appropriate

- The patient will need to be able to place the electrodes on his or her body appropriately and set the device as instructed (if used at home/independently)

- Is the patient able to inform the provider if the electrical stimulation is beginning to feel uncomfortable?⁽¹⁾

- **Assistive and adaptive devices:** Does the patient utilize any assistive or adaptive devices? Are they appropriate and used correctly?

- **Balance:** Assess the patient's balance in sitting and stance as indicated. Use a standardized tool such as the Berg Balance Scale (BBS) or Functional Reach Test as indicated

- **Cardiorespiratory function and endurance:** Assess vital signs as indicated and appropriate. The 6 minute walk for distance test (6MWT) can be used to assess endurance

- **Circulation:** Assess for signs of diminished circulation. Check peripheral pulses

- **Cranial/peripheral nerve integrity:** Assess peripheral nerve mobility if nerve involvement is suspected or indicated by the patient's chief complaint. Assess motor and/or sensory distribution of cranial and peripheral nerves as indicated

- **Ergonomics/body mechanics:** Assess for faulty body mechanics that might be contributing to the patient's pain

- **Functional mobility:** Assess functional mobility as indicated by underlying condition. Standardized tests that can be used include the Timed Up and Go (TUG) test, the FIM, the five times sit to stand test (FTSTST), and gait speed (measured using the 10 meter walk test)

- **Gait/locomotion:** Complete a thorough gait assessment as indicated by reason for referral. The Dynamic Gait Index (DGI) can be used to assess safety during ambulation

- **Joint integrity and mobility:** Assess joint integrity as indicated by symptoms and reason for referral

- **Motor function (motor control/tone/learning):** Evaluate motor function and muscle tone as indicated

- **Muscle strength:** Complete a thorough strength assessment throughout with a particular focus on the area where TENS is to be applied

- **Observation/inspection/palpation (including skin assessment)**

- Inspect skin for any signs of irritation or breakdown before and after treatment⁽¹⁾

- Assess for muscle atrophy⁽¹⁾

- **Posture:** Assess the patient's general posture

- **Range of motion:** Complete a thorough ROM assessment with a particular focus on the area where TENS is to be applied

- **Reflex testing:** Assess deep tendon reflexes

- **Self-care/activities of daily living (objective testing):** Complete an ADL assessment as indicated. Use a standardized tool such as the Barthel Index or FIM as indicated

- **Sensory testing:** Complete a thorough sensory assessment (e.g., light touch, temperature, pin-prick) of the area where TENS is to be applied
- **Special tests specific to diagnosis:**
 - Special tests used to assess pain might include:
 - Pressure algometry or dolorimetry – device used to obtain pain threshold and tolerance⁽³⁷⁾
 - Neuropathic Pain Scale (NPS) – an instrument that assesses specific qualities of neuropathic pain, such as intense, sharp, hot, dull, cold, deep, and superficial. There is also an item on the NPS to assess the overall “unpleasantness” of the pain⁽³⁵⁾
 - Brief Pain Inventory (BPI) – used to assess the effects of pain on the lives of patients⁽³⁵⁾
 - McGill Pain Questionnaire (MPQ) – a self-report questionnaire. Users select words from lists that best describe their pain. Numerical values are then assigned to the words
 - Analgesic intake

Assessment/Plan of Care

› **Contraindications/precautions**

- Patients who need this device or those with a diagnosis for which this device is used might be at risk for falls; follow facility protocols for fall prevention and post fall prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall prevention strategies. Discharge criteria should include independence with fall prevention strategies

› **Diagnosis/need for device/equipment:** Pain is the primary indication for TENS; please see *Indications for device/equipment*, above, for more details

› **Prognosis:** Prognosis will vary widely depending on underlying condition, severity of condition, and patient’s adherence to treatment plan⁽³²⁾

› **Referral to other disciplines:** Refer to other disciplines (e.g., occupational therapy, psychiatry) as indicated and appropriate. Consider referral to pain management clinic for chronic/refractory pain

› **Other considerations**

- TENS-like devices
 - A review of the literature reported that there are numerous “TENS-like” or “hybrid” TENS devices available for purchase; however, these devices are often not well studied. As a result, the efficacy of these devices is uncertain. The author of the review called for more research comparing these devices to standard TENS units, thereby allowing clinicians to make more evidenced-based choices when selecting a treatment modality⁽⁵⁾
 - Examples of “TENS-like” devices
 - Action potential simulation (APS)
 - Codetron
 - H-Wave therapy (HWT)
 - Interferential current therapy (IFC)
 - Microcurrent electrical stimulation (MES)
 - TENS pens
 - Transcutaneous spinal electroanalgesia (TSE)
- Perceptual threshold of touch⁽¹²⁾
 - A new use for TENS is to objectively measure the perceptual threshold of touch (PTT). Hand dexterity and grasp function are significantly important for work-related activities and ADLs. The ability of the body to accurately perceive touch pressure, also known as PTT, enables proper object manipulation and other functional motor tasks. Thus, it would be beneficial to clinicians and researchers to be able to measure impaired PTT in order to assess progress and outcomes
 - In a study involving 346 adults between the ages of 20 and 102 years, researchers in Sweden used TENS to objectively measure PTT (in mA) in the hands and feet. The goal was to establish norms for PTT in adults, as well as to assess if age, gender, handedness, right/left side, height, weight, or body mass index (BMI) had any influence on PTT
 - The researchers determined that 3.75 mA (range 2.50-7.25 mA) was the median for PTT in the hands, whereas PTT in the feet could not be established due to extreme variability about the median. Advancing age, male gender, and the right side were found to be the only factors that influenced PTT, in that it was higher

- Results of a randomized double-blind crossover study suggest that TENS is effective at reducing experimental pain in younger individuals (age 26±5), but does not reduce pain in elderly adults (age 67±5), however future studies are warranted⁽⁵⁰⁾
- Transelectrical nerve acupuncture stimulation (TEAS) can provide some positive effects on maintaining orthostatic tolerance when applied to the PC6 acupressure point used for at least 30 minutes daily⁽⁵¹⁾
 - Based on a study in China involving 14 male subjects. Patients were randomized into two groups: TEAS group (n = 8) and control group (n = 6)
 - Plasma hormones, plasma volume and heart rate were measured before and after treatment
 - Intervention consisted of patients laying in supine with head-down in a -6° from horizontal. Patients were asked to be completely bed ridden for 4 days (eating, washing, defecation, urination). TEAS was applied to the PC6 acupressure point for 30 minutes daily
 - Results at the end of the treatment indicate that TEAS treatment at the PC6 can increase orthostatic tolerance as well as cardiac deconditioning as a result of short-term bed rest
- › **Treatment summary:** (The following is a summary of the research related to TENS use in practice. The headings were created for ease of reading; there is some obvious overlap between the categories [e.g., chronic pain and musculoskeletal pain])
 - Acute pain
 - There is insufficient evidence to draw conclusions regarding the efficacy of TENS in the management of acute pain⁽¹³⁾
 - Based on a Cochrane systematic review
 - Review included 12 randomized controlled trials involving 919 subjects in total
 - Meta-analysis could not be completed (inadequate available data)
 - Chronic pain
 - The available evidence regarding the efficacy of TENS in the management of chronic pain is inadequate, prohibiting firm conclusions on its implementation for this condition⁽¹¹⁾
 - Based on a Cochrane systematic review
 - Review included 25 randomized controlled trials involving 1,281 subjects
 - Meta-analysis could not be completed (variable methodology between trials)
 - Cancer pain
 - The available evidence regarding the efficacy of TENS in the management of cancer pain is inadequate, prohibiting firm conclusions on its implementation for this condition⁽¹⁴⁾
 - Based on a Cochrane systematic review
 - Review included 3 randomized controlled trials involving 88 subjects
 - Meta-analysis could not be completed (variable methodology between trials)
 - Chronic low back pain
 - TENS does not appear to be effective in the management of chronic low back pain; however, further research is recommended⁽¹⁵⁾
 - Based on a Cochrane systematic review
 - Review included 4 randomized controlled trials involving a total of 585 subjects
 - Meta-analysis could not be completed (heterogeneity); qualitative summary was performed
 - There is no significant difference in pain level in patients with chronic low back pain when using adjusted TENS amplitude versus fixed TENS amplitude⁽⁴⁶⁾
 - Neck pain
 - Electric point TENS might improve pain, but not cervical range of motion, in patients with upper trapezius trigger points⁽¹⁶⁾
 - Based on a randomized controlled trial in the United Kingdom that involved 78 patients who received electric point TENS or sham TENS
 - Burst-type TENS might improve cervical range of motion and pain in patients with upper trapezius trigger points⁽¹⁷⁾
 - Based on a randomized controlled trial of 76 patients in Spain who received burst-type TENS or sham TENS
 - Manual therapy and TENS are equally effective in reducing neck pain⁽¹⁸⁾
 - Based on a randomized controlled trial in Spain, involving 47 patients who received manual therapy or TENS
 - Both groups experienced an equivalent reduction of symptoms

- Cervical spinal mobilization and TENS are equally effective in reducing numbness, tingling, and pain in patients with cervical radiculopathy⁽¹⁹⁾
 - Based on a randomized controlled trial of 75 patients in India who received cervical mobilization and isometric neck exercises, heat therapy and isometric neck exercises, or heat therapy and TENS
 - All groups experienced an equivalent reduction of symptoms
- Other musculoskeletal pain
 - Solid conclusions regarding the efficacy of TENS for the management of knee pain (caused by osteoarthritis [OA]) could not be made as the current body of evidence has significant methodological flaws (e.g., underpowered studies)⁽²⁰⁾
 - Based on a Cochrane systematic review
 - Review included 18 randomized or quasi-randomized controlled trials involving a total of 813 subjects
 - Eleven trials evaluated TENS
 - One evaluated TENS and interferential current
 - Two evaluated pulsed electrical stimulation
 - Four evaluated interferential current
 - Meta-analysis was completed
 - The authors report numerous methodological concerns in regards to the included trials
 - In the short term, TENS might be effective in reducing pain in individuals with OA of the knee⁽²¹⁾
 - Based on a systematic review investigating the efficacy of various treatment interventions
 - Review included 11 trials on TENS (authors included interferential current in this grouping) involving a total of 425 subjects
 - TENS might improve the central activation ratio (CAR) of the quadriceps muscle in individuals with knee OA in the short term⁽²²⁾
 - Based on a randomized controlled trial conducted in the United States
 - The general purpose of the study was to investigate if TENS and/or “focal knee joint cooling” might enhance quadriceps activation in individuals with knee OA
 - Participants in the study all had a diagnosis of tibiofemoral OA
 - Thirty-three participants were randomized to one of three groups
 - TENS group – 45 minutes; sensory stimulation
 - Focal knee joint cooling treatment – bags of crushed ice; placed around knee joint; duration of 20 minutes
 - Control group – rest
 - Individuals were assessed at baseline and at 20, 30, and 45 minutes
 - Outcome measures included (but not limited to)
 - CAR
 - “Calculated by dividing the force measurements of the maximal voluntary contraction by that of the force produced by the superimposed burst plus the maximal voluntary contraction as previously performed”⁽²²⁾
 - Pain measures
 - Results
 - At 20 minutes, 30 minutes, and 45 minutes, when comparing TENS to the control group, there was a significantly greater change in the CAR score in favor of the TENS group
 - At 20 minutes, when comparing the joint cooling treatment to the control group, there was a significantly greater change in the CAR score in favor of the cooling group
 - The authors concluded that more research is warranted to further assess the potential for improvements in strength, in the long term, when using these modalities as a supplement to other therapies
 - TENS was reported to significantly reduce pain in the short term in individuals with fibromyalgia⁽²³⁾
 - Based on a randomized crossover trial in Sweden; no washout period was incorporated in this trial
 - The trial involved 32 individuals with fibromyalgia
 - The participants were randomized to 1 of 2 groups (subjects were trained on the interventions then carried out their own treatment)
 - Superficial warmth – 107.6°F (42°C); individuals were allowed to use the device from 45 minutes to 2 hrs/day
 - TENS – individuals were allowed to adjust the intensity and duration (however, the device has to be used for at least 30 minutes/session)
 - Following 3 weeks of intervention, the individuals crossed over to the other intervention for 3 weeks

- Primary outcome measure was the VAS
- Results
 - There were no statistically significant differences between the interventions in terms of pain reduction; after each intervention a significant decrease in pain was detected
- TENS does not appear to be as effective as interferential current (IFC) at inducing upper trapezius relaxation in computer users with chronic nonspecific neck discomfort⁽³⁸⁾
 - Based on a randomized controlled trial with electromyographic (EMG) analysis conducted in Brazil
 - Sixty-four females with history of neck discomfort were randomized to receive TENS or IFC for 3 consecutive days
 - Muscle relaxation was assessed using EMG. Pain was assessed with a VAS
 - A significant pain decrease was found in both groups; however, only the IFC group had a clinically important improvement
- TENS might reduce pain and improve pelvic floor muscle activity in men with chronic pelvic pain syndrome⁽²⁴⁾
 - Based on a randomized controlled trial in Egypt that involved 40 men with chronic pelvic pain syndrome who received TENS and antibiotics or sham TENS and antibiotics
- TENS, in combination with pelvic floor relaxation exercises, might reduce pain in women with postpartum dyspareunia⁽²⁵⁾
 - Based on a research study in Italy of 45 women with postpartum dyspareunia
- TENS might reduce post-partum uterine contraction pain during breast-feeding⁽³⁹⁾
 - Based on a randomized controlled trial conducted in Brazil, involving 32 post-partum women
- Progressive muscular relaxation exercises appear to be more effective than TENS for reducing stress level in patients with tension-type headache (TTH)⁽⁴⁰⁾
 - Based on a randomized controlled trial conducted in India
 - Thirty patients with TTH were allocated to practice progressive muscle relaxation exercises or to receive TENS
 - TENS electrodes were placed bilaterally either on the head at the site of the pain or on the occiput. Treatment was 15 minutes per day for 7 days
 - Outcomes measured were pain intensity with VAS and level of stress with Lakaev Academic Stress Response Scale
 - Pain reduction was similar between the 2 groups, but progressive muscle relaxation exercises were more effective in reducing stress
- Cardiorespiratory/circulation and TENS
 - TENS might alleviate postoperative pain and improve pulmonary function in patients following abdominal surgery⁽⁴¹⁾
 - Based on a randomized controlled trial conducted in Japan that compared TENS, placebo TENS and no TENS (control) for 1 hour a day for 3 days postoperatively
 - Forty-eight patients who underwent abdominal surgery participated
 - Outcome measures included pulmonary functions (vital capacity and cough peak flow, measured with a spirometer), and pain measured with a VAS
 - The TENS group had significant reductions in postoperative pain compared with the placebo and the control group
 - There was improvement in the pulmonary functions of the TENS group at mid intervention and post intervention, but not in the placebo TENS group or the control group
 - Acu-TENS might assist in reducing dyspnea in individuals with chronic obstructive pulmonary disease (COPD)⁽²⁶⁾
 - Based on a randomized controlled trial in Hong Kong involving 46 individuals
 - Subjects all had a diagnosis of stage I or stage II COPD
 - Subjects were randomized to one of two groups
 - Intervention group – Acu-TENS; 45 minute duration; applied over “bilateral acupoints Ex-B1” (an acupuncture point historically used to treat individuals experiencing shortness of breath); frequency was 4 Hz and pulse width was 200 microseconds; intensity was adjusted to just below the level of perceived discomfort/pain
 - Control group – placebo-TENS; 45 minute duration
 - Outcome measures
 - Forced expiratory volume in one second (FEV1)
 - Forced vital capacity (FVC)
 - Dyspnea – assessed via a shortness of breath VAS

- Results
 - When comparing the two treatment arms, the intervention group was found to have a significantly greater improvement in FEV1
 - The experimental group experienced a greater reduction in dyspnea as well
 - The authors conclude that further research is indicated to assess long-term outcomes
 - A similar RCT study from China, studied the effects of Acu-TENS on patients with stable COPD. Results indicate that Acu-TENS, when applied over the EX-B-1 (Dingchuan), BL-13 (Feishu), BL-23 (Shenshu), and ST-36 (Zusanli), improved scores in the FEV, COPD assessment test (CAT), and Dyspnea Visual Analogue scale (DVAS)⁽⁴⁸⁾
 - Fifty patients with stable COPD participated in this single-blind randomized, placebo-controlled study
 - Patients were randomized to the Acu-TENS group (n = 25) or control group (n = 25)
 - Patients in the Acu-TENS group had electrodes placed on the EX-B-1, BL-13, BL-23, and ST-36 acupressure points with a frequency of 2Hz. The control group had electrodes placed on the same acupressure points, but with no electrical current
 - Treatment was 40 minutes, 2x/ week for 4 weeks (total of 14 sessions)
 - Results at the end of treatment indicate that placement of electrodes at these specific acupressure points can improve outcomes in the FEV 1, COPD assessment test (CAT), and Dyspnea Visual analogue scale (DVAS)
- Motor level TENS might lead to increased blood flow to underlying musculature⁽¹⁰⁾
 - Based on a study involving 33 healthy women in Sweden
 - Participants were randomized to one of three treatments (15 minutes each) over the trapezius muscle
 - Sensory level, 80-Hz TENS – goal was to stimulate “strong sensations of paresthesia” without muscular contractions
 - Motor level, 2-Hz TENS – goal was to stimulate “strong, but not painful” muscular contractions
 - Subliminal TENS – control
 - Blood flow was assessed at regular intervals via photo plethysmography
 - Results
 - The motor stimulation group experienced a significantly greater increase in blood flow to the muscle tissue when compared to the other treatment arms
 - There were no significant changes in skin blood flow in any of the treatment arms
- Neurological conditions and TENS
 - TENS, in addition to therapeutic exercise, was reported to increase hand function (immediately after treatment) in individuals with a history of stroke⁽²⁷⁾
 - Based on a nonrandomized controlled trial in Turkey that involved 36 individuals
 - All participants were in the acute phase of recovery from a stroke
 - Treatment arms
 - TENS group
 - Intervention for 1 hour/day, for 10 days consisting of therapeutic exercises (Bobath approach)
 - One hour of TENS to the extensor digitorum communis and extensor carpi radialis (set to elicit muscle contractions)
 - Control group
 - Intervention for 1 hour/day, for 10 days consisting of therapeutic exercises (Bobath approach)
 - Outcome measures included tests of kinesthesia and proprioception, as well as a hand function test and hand movement scale
 - Results
 - When comparing the two treatment arms, hand function increased significantly in the TENS group post intervention (but not the control group)
 - No other significant differences were detected between groups post intervention
 - TENS, in conjunction with standard rehabilitation, might improve strength and reduce spasticity in individuals who have recently had a stroke⁽²⁸⁾
 - Based on a randomized controlled trial in China involving 62 participants
 - All participants had recently had a stroke (average of 9.2 days from onset)
 - The participants were randomized to 1 of 3 groups
 - TENS
 - Administered to 4 acupuncture points in the impaired lower extremity (100Hz, constant mode, intensity to tolerance)
 - Five days a week for 1 hour, for 3 weeks

- Also received standard rehabilitation
- Placebo TENS – also received standard rehabilitation
- Standard rehabilitation alone
- Outcome measures included
 - Composite Spasticity Scale
 - Maximum isometric voluntary contraction
 - Timed Up & Go (TUG) test
- Results (statistically significant)
 - When comparing TENS to the other treatment arms:
 - The TENS group had a greater amount of participants with normalized muscle tone
 - The TENS group had increased dorsiflexor strength
 - The TENS group had reduced antagonist co-contraction
 - The authors concluded that more research is warranted to support these findings
- TENS application can reduce spasticity in hemiplegic patients with spasticity in their lower extremities⁽⁴⁹⁾
 - Twenty-seven patients with acute CVA (spasticity of at least grade 1 on Ashworth scale) and 24 healthy individuals used as the control group were included in this study
 - EMG studies were taken pre and post TENS for both groups
 - Primary outcome measures used for this study were the Brunnstrom stage, Ashworth scale, and time taken to walk 10 meters
 - A single session of TENS for 30 minutes with electrodes placed on the tibialis nerve. Frequency and duration was set at 50HZ and 100 ms respectively with amplitude not exceeding 50mA
 - Results show a significant decrease in reducing spasticity levels as well as an increase in walking speed after a single session of using TENS
- The available evidence regarding the efficacy of TENS in improving gait speed post stroke is inadequate, prohibiting firm conclusions regarding implementation⁽²⁹⁾
 - Based on a systematic review with meta-analysis
 - The review assessed functional electrical stimulation (FES) and TENS
 - Only one randomized trial was found on TENS related to the subject matter under investigation. The meta-analysis was of FES results only
- Researchers of a randomized controlled trial conducted in Myanmar suggest that addition of TENS to standard physical therapy might provide more effective reduction of clinical spasticity in patients with subacute spinal spasticity⁽⁴²⁾
 - Sixteen patients with new traumatic SCI and clinically verified spasticity who reported plantar flexor spasticity as pain or limitation of daily activity or both participated
 - Participants were randomized to an experimental group that received TENS before physical therapy or to a control group that received physical therapy only
 - TENS was applied in 60 minute sessions over the bilateral common peroneal nerve with the patient in a supine position, followed by 30 minutes of physical therapy every weekday for 3 weeks
 - The control group received the same physical therapy for 30 minutes every weekday for 3 weeks
 - The primary outcome measure was the composite spasticity score derived from summation of ankle jerk score, muscle tone score, and ankle clonus score
 - The combination of TENS with standard physical therapy resulted in better reduction of clinical spasticity in both an immediate and a short-term (3 weeks) basis. Long term results were not obtained
- Researchers in China found that TENS effectively decreases pain in patients with SCI⁽⁴³⁾
 - Based on a randomized controlled trial that involved 52 patients with SCI who had central pain
 - Participants were randomized into an experimental group treated with TENS for 20 minutes 3 times a week for 12 weeks, or a control group that received sham TENS for the same amount of time
 - The primary outcome measure was the MPQ
 - Results indicated that 12 weeks of TENS treatment is effective for relieving pain in patients with SCI
- Wound Care
 - Researchers of a pilot study conducted in the United States suggest that high-intensity TENS is effective for reducing pain associated with wound care procedures⁽⁴⁴⁾

- Twenty-three inpatients with open wounds who rated pain intensity during their first dressing change on a numeric scale of 0-10 were enrolled
 - High intensity TENS was applied using 4 square electrodes placed on the top and bottom and both sides of the wound beyond the border of the dressing 30 minutes prior to the dressing change. The amplitude was increased every 5 minutes until the dressing change began and then once during the dressing change to achieve and maintain the strongest tolerable sensation during the wound care procedure
 - The high intensity TENS significantly reduced pain by a mean of 2.0 on the numeric scale. The effect was significant for subjects with severe pain during the first dressing change, but not for subjects with moderate pain
 - Temporomandibular joint disorders^(33,45)
 - Authors of a 2014 systematic review found no randomized clinical trials of use of TENS to treat temporomandibular joint disorders⁽³³⁾
 - Researchers of a 2014 randomized controlled trial conducted in India suggest that TENS is an effective adjuvant modality in the management of pain associated with TMD⁽⁴⁵⁾
 - Forty patients with TMD were randomly assigned to a group treated with medication alone (analgesics and muscle relaxants), or to a group receiving TENS therapy in combination with medications
 - Pain was measured using the VAS
 - A significant improvement was observed in both groups; however, on comparative analysis, medication with adjuvant TENS was found to be more effective than medication alone in controlling pain
 - Phantom limb pain⁽³⁰⁾
 - There is insufficient evidence to support the use of TENS to treat phantom limb and stump pain
 - Acupressure like TENS was able to increase the pain threshold of cold-induced pain when electrodes were placed on the TE5 (Waiguan) and PC6 (neiguan) acupoints⁽⁴⁷⁾
 - Forty-eight patients were divided into three groups: TENS with electrodes of 1 cm² area, TENS with electrodes of 15 cm² area, or placebo group
 - Study consisted of three phases: cold-induced pain without electroanalgesia, cold-induced pain with electroanalgesia or placebo, cold-induced pain post-electroanalgesia
 - Pain was measured using the VAS
 - Results of the study indicate that acupressure like TENS can increase the pain threshold when applied to the TE5 and PC6 acupoints
- › See *Description, Indications of device/equipment, and Guidelines for use of device/equipment*, above

Problem	Goal	Intervention	Expected Progression	Home Program
Acute pain	Reduce/eliminate pain	<p>TENS</p> <p>See <i>Guidelines for use of device/equipment and Treatment summary</i>, above</p>	N/A	Implement a home program to support the desired outcomes, as appropriate and indicated

Chronic pain	Reduce/eliminate pain	<p>TENS</p> <p>See <i>Guidelines for use of device/equipment and Treatment summary</i>, above acupuncture-like TENS might be used for the treatment of chronic pain;⁽⁹⁾ however, a review of the literature reports more research with solid methodology is warranted to better support its efficacy and delineate optimal parameters⁽⁴⁾</p>	N/A	Implement a home program to support the desired outcomes, as appropriate and indicated
Other impairments TENS could potentially be used to treat include reduced motor function, reduced strength, spasticity, and shortness of breath	Improve motor function and strength, reduce spasticity and shortness of breath	<p>TENS</p> <p>Please see <i>Guidelines for use of device/equipment and Treatment summary</i>, above</p>	N/A	Implement a home program to support the desired outcomes, as appropriate and indicated
<p>Risk factors: The individual might experience skin irritation⁽⁹⁾</p> <p>Adverse events of TENS are rare⁽⁴⁾</p>	Minimize risk of skin irritation and adverse events	<p>Patient education</p> <p>See <i>Contraindications/precautions</i>, above</p> <p>Ensure the patient's sensation is intact</p> <p>Ensure the appropriate level of supervision is provided at all times; if the patient is utilizing the device at home, educate and ensure independence with skin inspections</p> <p>The patient should be able to shut the device off independently</p>	N/A	N/A

Desired Outcomes/Outcome Measures

- › Minimize risk of skin irritation and adverse events
 - Occurrence, frequency of adverse events

- › Reduce/eliminate pain
 - VAS, NRS
 - MPQ
 - BPI
- › Improve motor function and strength
 - Manual Muscle Testing (MMT) or other strength outcome measure as indicated by condition
 - Function measures as indicated by condition
- › Reduce spasticity

Muscle tone measured with Modified Ashworth Scale, deep tendon reflexes, and clonus Maintenance and Prevention

- › TENS units should be routinely inspected by a qualified technician

Patient Education

- › Patients and their families require detailed information and extensive education for home use
- › See: Transcutaneous Electrical Nerve Stimulation (TENS), WebMD Web site at <http://www.webmd.com/pain-management/tc/transcutaneous-electrical-nerve-stimulation-tens-topic-overview>
- › See: Transcutaneous Electrical Nerve Stimulation (TENS), Mayo Clinic Web site at <http://www.mayoclinic.org/tens/IMG-20006686>

Coding Matrix

References are rated using the following codes, listed in order of strength:

M Published meta-analysis	RV Published review of the literature	PP Policies, procedures, protocols
SR Published systematic or integrative literature review	RU Published research utilization report	X Practice exemplars, stories, opinions
RCT Published research (randomized controlled trial)	QI Published quality improvement report	GI General or background information/texts/reports
R Published research (not randomized controlled trial)	L Legislation	U Unpublished research, reviews, poster presentations or other such materials
C Case histories, case studies	PGR Published government report	CP Conference proceedings, abstracts, presentation
G Published guidelines	PFR Published funded report	

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